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ABSTRACT

This paper summarizes the state of instructional software being produced by commercial sources in the United States as of late 1984, and reports some of the trends which led up to that state. After a brief background synopsis and description of the procedure used to obtain information, the document discusses such topics as: amount of software available, subject areas for which software was produced, growth of available software by subject, trends in the production of new software, grade levels of software, classification of program types, software quality, and trends in software quality. Based on the results of the study, the conclusion identifies four main weaknesses and four impressive strengths of the instructional software field. Four data tables and 10 graphs illustrate the paper's findings; a bibliography and computer glossary complete the document. (JB)

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INSTRUCTIONAL SOFTWARE, 1984

TRENDS AND STATE OF THE ART

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The purpose of this paper is to summarize the state of instructional software being produced by commercial sources in the U.S. as of late 1984 and to report some of the trends which led up to that state. The paper considers the amount of software available, the subject areas and grade levels for which it was produced, the types of programs produced, and the quality of products as reported by a wide variety of evaluation sources.

This paper is based on a study of data collected over the past 4-1/2 years. These data, although they are considered by EPIE to be fairly representative of the software market, were not from a randomly selected or structured sample; furthermore, no experimental controls were used. Therefore, the results and conclusions are offered not as proven facts but as observations which are suggestive of directions for further inquiry and for tentative guidance in decision-making by educational consumers and software producers.

BACKGROUND AND THESIS

The first uses of computers in teaching occurred about 1964 (Haven, 1967). Twelve years later, only 26.5% of the nation's districts had access to a computer for instruction, and this usually meant only two or three student stations for an entire district (Bukowski and Korotkin, 1976). The main obstacle to faster growth was economic: In the mid-seventies, schools were paying up to $100 per student per year just for computer hardware!

In 1977, Commodore Business Machines shipped the first editions of the PET 2001, the first fully assembled, mass-produced microcomputer. The Radio Shack TRS-80 and Apple II came along in 1978. Many educators soon began to realize the important economic advantages of microcomputers over the minicomputers then in vogue: Per-pupil costs for computer hardware could be cut to as low as $6 per year. Furthermore, enhancements such as color, graphics, and sound offered the potential of providing exciting and effective instructional strategies never before possible.

Very soon, a handful of companies began to produce programs to do instruction on microcomputers. These organizations, mostly very small and with limited resources, were started either by teachers or computer professionals. There weren't many products, and the quality was generally poor.

It wasn't long before microcomputers were moving into schools in a big way. In 1982, a Market Data Retrieval telephone survey found at least one microcomputer in over 60 per cent of U.S. school districts; they also found that the number of micro-using districts had grown by 43.5 per cent over the number for 1981.

The fact that the microcomputer had arrived on the education scene was not lost on commercial publishers and distributors of textbooks and other teaching materials. The number of companies

involved in supplying educational microcomputer software grew from a few dozen in the late seventies to over 700 today, and new companies are still appearing at a rapid rate (based on producer information in EPIE's database).

One might expect that this tidal wave of commerical software producers would by now, 8-1/2 years since the first Commodore PET, have resulted in the creation of most of the computer programs needed by schools and led to the industry-wide attainment of very high design and production standards for software. Certainly, much of the commentary in the recent computer education press would lead one to believe that this was well on its way to realization. However, the main theme of this paper is just the opposite:

(1) Far from having produced all of the programs needed, less than half of what would be desirable is available.

(2) Rather than taking advantage of the unique, powerful capabilities of microcomputers to implement new, more effective pedagogy, most commercial software efforts are mired in the use of the same timeworn approaches that were rooted in the limitations of the old media.

(3) Rather than reaching levels of excellence, over-all software quality improved through 1982 but then leveled off on a plateau which could be best described as barely adequate. (This is not to belittle or ignore the modest number of excellent products available, but they are the exception.)

In summary, the educational software field, although having great potential for improving education, is just emerging from infancy and has a lot of growing to do.

PROCEDURE

EPIE Institute produces TESS-The Educational Software Selector, an extensive directory of commercially produced instructional and administrative software for all microcomputers in common use in U.S. schools. TESS is available in both print and electronic formats, the latter being on CompuServe.

In order to produce TESS, it is necessary for EPIE to maintain a computerized database of all of the software and producer information included in the directory. This information is provided by the producers themselves. Periodically, EPIE sends out questionnaires to all known producers of educational software. Many companies respond readily; others are coaxed by means of a persistent follow-up program, and information is received from most of them. Where the producer has completed EPIE's questionnaire, this information is used and is given first priority on a place in the next edition of TESS. If the producer does not complete the questionnaire, the EPIE staff extracts the needed information from whatever descriptive material the producer has supplied. In this way, EPIE has added information on about 2,200 new products to its database in each

of the past two years.

Two kinds of information are reported in this study: state-of-the-art summaries and trends. The former type of information is based on computer analysis of quantity, subject area, grade level, program type, and quality data on all of the 6,126 unique products included in the latest edition of TESS, published in February, 1985. Data collection for this edition was suspended at the end of October, 1984, so that is considered to be the date for which the information is accurate. It is estimated that the database at that time contained information on about 80 per cent of the commercially produced software intended primarily for education. Because it does contain information on such a high proportion of available software, the contents of the database are considered by EPIE to be highly representative of the nature of that software.

The study of trend information for this paper was possible because the database contains copyright dates for 2,757 of the products described. Using the copyright date as a selection criterion, it was possible to do analyses, for each of the years 1980 through 1984, of the same parameters as were studied to arrive at the state-of-the-art summaries, i.e., quantity, grade level, subject, program type, and quality. Knowing the values of these parameters, it was possible to look for trends and thus to seek understanding of what has led up to the present state of the software field.

AMOUNT OF SOFTWARE AVAILABLE

As stated above, in late 1984, the database upon which this report is based contained 6,126 commercial instructional software products for all microcomputers used commonly in schools today. Assuming that EPIE's database contains 80 per cent of available software products, there were about 7,700 programs on the market in late 1984.

EPIE's database was actually started in 1980. A few descriptive statistics were collected from the database in 1981 and are suitable for use as a basis of comparison in the matter of total amount of software. In August, 1981, the database contained 1,210 products, which was estimated to represent about 70 per cent of all products on the market at that time. Assuming that the estimates just cited of the proportion of all software available are reasonably accurate, one can estimate that the pool of available commercial software grew by approximately 4.5 times in the 38 months from August, 1981 to October, 1984. This amounts to about 160 products per month, or almost 2,000 per year.

We felt that it would be interesting to try to get a rough idea of how the pool of available software compares in size with what is actually needed. In 1981, Prof. Ludwig Braun, then of State University of New York at Stony Brook, estimated that it would take a minimum of 4,600 unique, limited-scope programs to meet the needs of a school district that wished to use, or at

least have the option of using, computer-oriented instruction in all facets of its curriculum. Comparing EPIE's estimate of 7,700 programs available in late 1984 with Prof. Braun's estimate, one might believe that schools are well on their way to having their instructional software needs met, at least in terms of quantity. However, one who explores our database will quickly note that there is a great deal of overlap among programs with regard to the topics they cover. For example, the EPIE database describes over 50 programs which help students learn how to add single-digit numbers. The exact extent of this overlap is unknown, but we estimate that the number of unique topics covered by programs described in the EPIE database is less than one-fourth of the total number of programs. This would put the number of topics at 1,900 or less. We believe that producers have a long way to go just to provide computer-oriented options for teaching most facets of school curricula. And this is without consideration of product quality, which is, as we shall see, another matter for strong concern.

SUBJECT AREAS FOR WHICH SOFTWARE WAS PRODUCED

Table 1 shows the subject areas for which the largest amounts of software were available in October, 1984. It is not surprising that most heavily supported subject is Mathematics, as it is the curriculum area where computer-oriented instruction got its start in the 1960's (Haven, 1967), and it has been the dominant one ever since. However, the predominance of software for Mathematics is somewhat misleading, as a very large proportion of it (over 75 per cent) is devoted to basic skills topics. Actually, less than a quarter of Math software supports secondary level math courses like Trigonometry, Analysis, Calculus, Probability, and Statistics. Almost the identical situation exists in English/Language Arts, where again over three quarters of the products are intended for use in teaching basic skills. There is definitely a need for producers to expend more effort on producing programs to support higher level Mathematics and English courses.

Except for Teaching About Computers, all of the subjects listed in Table 1 would have been expected to be among those for which the most software existed, as they are subject areas that make up the backbone of the curricula in most schools. The presence of Teaching About Computers is not surprising, either, as its sub-area Programming was one of the most widespread occupations of early computer-oriented classes (Haven, 1967), and has continued to be a very important pursuit in most schools having microcomputers.

There are two subject areas which vast numbers of our nation's students study in many years of their academic careers, and yet for which there is only a relatively small amount of software available. These subjects are Fine Arts (Art and

Music) and Business. The complements of software to support them in late 1984 constituted only 2.5% (153 products) and 2.1% (130 products), respectively, of the entire software pool. Interestingly, however, as we shall see in succeeding discussions, the small amount of Fine Arts software available also includes some of the best programs on the market.

Table 1. Amount of Software Supporting Individual Subject Areas, 1984

	Total Products in Database	Proportion of Total
Mathematics	1,575	25.7%
Science	828	13.5%
English/Language Arts	736	12.0%
Reading	608	9.9%
Social Studies	321	5.2%
Teaching About Computers	311	5.1%
Foreign Languages	273	4.5%
Fine Arts	153	2.5%
Business	130	2.1%

Before commenting further on the apparent lack of software for Business, I should make clear one fact which could lead to a misunderstanding when considering these data. EPIE has attempted to limit its database to software with a specific educational intent. Therefore, most general-pupose programs such as word processors, spreadsheets, and data management systems, have been excluded. Clearly, many of the needs of Business classrooms are met by such general-purpose programs, and they are in wide use in many schools. Consequently, one might argue that this is the reason that our statistics show such a small complement of Business software.

Undoubtedly, this argument has some validity. However, the same sort of reasoning also could be applied to Mathematics, Science, and Language Arts, where general-purpose programs also have wide applications. Yet, in these subject areas, a great variety of special-purpose software has been developed to serve the particular needs of the subject area.

The dearth of special-purpose Business software is difficult to understand, and this author has no answer to why the situation exists. Business Education was one of the first school departments to make substantial use of computers (Bukowski and Korotkin, 1976). Obviously, it is also one of the areas where computers find the most use in the world of work. Furthermore, much of Business Education is directed toward preparing for occupations and thus should be related rather closely to the world of work. It would seem that this would be a natural place for software development to flower. However, this does not seem

to have happened yet.

GROWTH OF AVAILABLE SOFTWARE BY SUBJECT

The statistics collected in 1981 from EPIE's software database also included measures of the amounts of software available in several subject areas. By extrapolating these data, and the data from the 1984 database, to the total body of software available at their respective times, it is possible to estimate, albeit roughly, the growth in the amount of software for individual subject areas. Table 2 shows this sort of estimate for many of the subjects widely taught in our schools. Note that the over-all body of software (all subjects) grew by over four times in the four-year period shown.

Table 2. Estimated Growth of Software in Individual Subject Areas, 1981-84

	Increase from 1981 to 1984	Total Products, 1984
All Subjects	>4 times	7,700
Industrial Arts	>10 times	70
Teaching About Computers	>9 times	390
Home Economics	<8 times	120
Health	<6 times	80
Business	<5 times	160
Reading	<5 times	760
Social Studies	<5 times	400
English/Language Arts	<4 times	920
Fine Arts	<4 times	190
Mathematics	>3 times	1,970
Science	<3 times	1,030

The fairly large percentage increases for Industrial Arts, Home Economics, and Health are probably due to the fact that there were very few programs available for these subjects in 1981 - a relatively small increase in numbers of programs would appear large relative to the small base for 1981. The large growth in software for Teaching About Computers is thought to be because producers recognized that, some current controversy notwithstanding, computer programming and computer literacy have become widely accepted as necessary parts of the curriculum and are thus "safe" subjects for which producers can develop products without the greater degree of risk inherent in some other areas.

The one subject for which it seems that software is growing at an unduly slow rate is Science. This situation is somewhat similar to that discussed above for Business, in that the work world of science uses computers a great deal. One might think that this would lead to heavy use in the school subject and

consequent heavy development by producers. However, although the total amount of software available is quite substantial, being second in the over-all standings, the growth in quantity of science software is definitely not keeping up with that in many other subject areas.

Several subject areas other than those shown in Table 2 had small complements of software in 1984 which had grown from none or only a few products in 1981. These include Agriculture, Aviation, Driver Education, Guidance, Library Skills, and Religion.

TRENDS IN THE PRODUCTION OF NEW SOFTWARE

As described in a preceding discussion, a longitudinal study of the software produced in each of the years 1980 through 1984 was undertaken. One statistic computed was the relative proportion of the total software produced represented by products for each subject area. This value for most subjects was either too sporadic to indicate a trend of any kind or was fairly level. Table 3 shows the average production levels for the subjects where outputs were stable.

Table 3. Approximate Production Levels of Products for Selected Subjects, 1980-84

	Avg. Proportion of All Products Produced Each Year
Business	3 %
Early Childhood	3 %
English & Language Arts	11 %
Fine Arts	2 %
Health	1 %
Home Economics	2 %
Industrial Arts	1 %
Library Skills	1 %
Logic & Problem Solving	2 %

Software production for a few subjects either accelerated or decelerated significantly; information for these is shown in Figure 1. Software output for Teaching About Computers accelerated at the fastest rate, about 1.3 per cent per year. Close behind it were Foreign Language and then Guidance.

The rate of producing Mathematics software decreased drastically from 1980 to 1981, but seems to have more or less leveled off after that. The apparent decreases in relative effort devoted to providing Science and Social Studies software are matters for some concern. The proportion of Science software increased from 13.5 per cent in 1980 to 20.5 per cent in 1981. It has been on the decline ever since, to a low of 10.6 per cent of programs produced in 1984. Although the total pool of Science software is relatively large, much of it was produced several years ago and may not partake of some of the more recent advances in software design. Furthermore, there are some areas of Science instruction which are as yet poorly served just in terms of the quantity of software available, not to mention the inclusion of new design principles. For example, as is described in a succeeding discussion, there is a very limited amount of software available for teaching Science in the lower grades.

The production of Social Studies software increased until 1982 to a level of 6.4 per cent declined about 2 per cent per year through 1984. If EPIE's database contains 80 per cent of the software extant in 1984, then the entire complement of Social Studies products is only about 400 programs. This is certainly a small supply considering the importance this subject has in our curricula. It would seem that some means must be found to stimulate the production of new software in both Science and Social Studies.

GRADE LEVELS OF SOFTWARE

Figure 2 shows the relative amounts of software available in 1984 for each of six grade level ranges, Preschool/Kindergarten through College, including all subject areas. It is apparent that the distribution is somewhat bell-shaped with a slight skew to the right, that is to the higher grades. The median grade level is centered in the Junior High range at 7.4.

The median grade level for programs appropriate for most subject areas is within one grade of the over-all median. However, the grade-level distributions for five subjects depart markedly from this norm, two on the low side and three on the high. Figure 3 shows the distribution of programs for Mathematics and Reading, both of which are skewed to the lower grades. The median grade for Math products, 5.8, is not surprising in light of the earlier observation that such a high proportion of this software is aimed at basic skills instruction. The even lower median grade for Reading, 4.7, is also to be expected, as most Reading instruction is done in the lower grades.

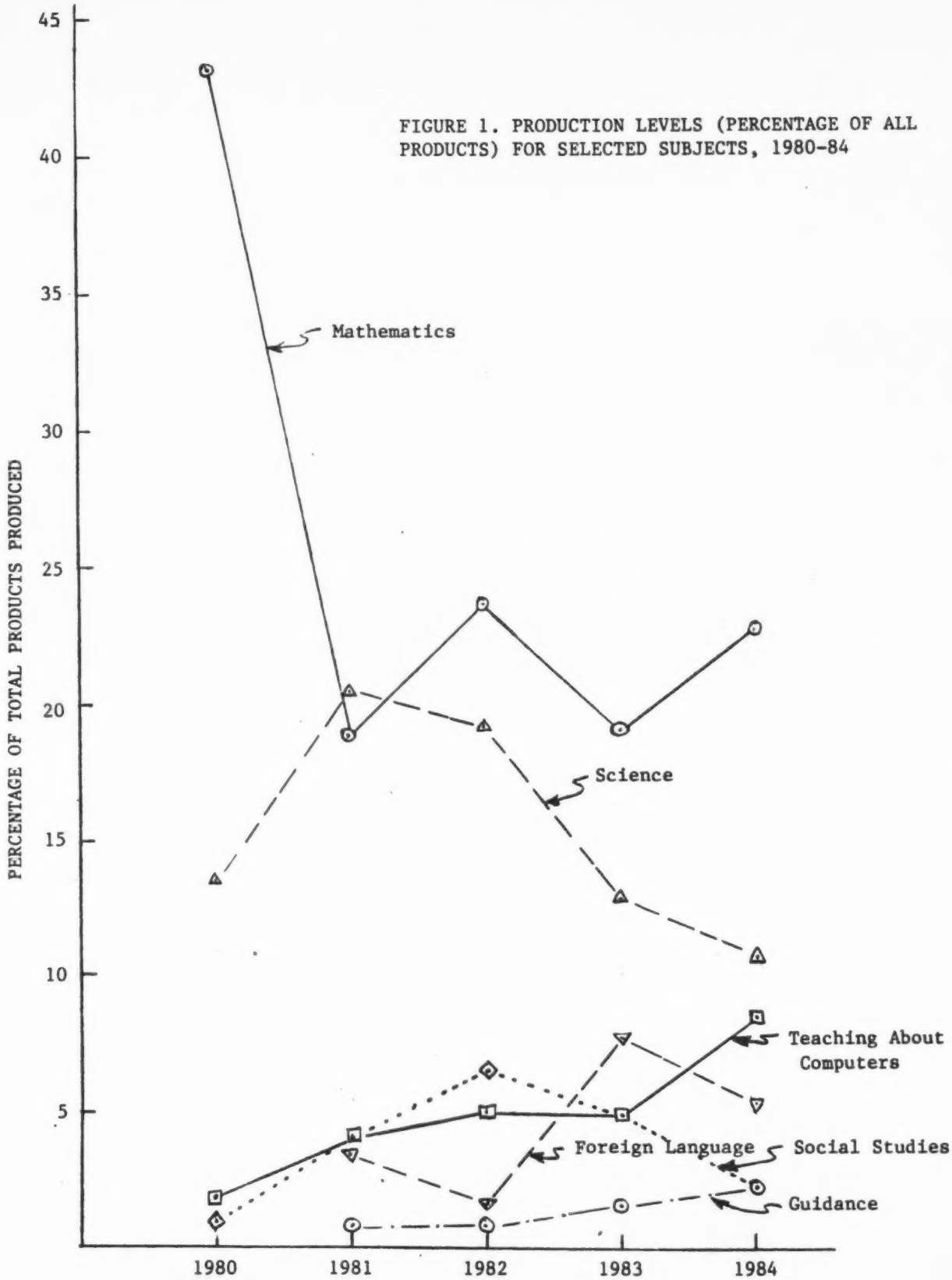


FIGURE 1. PRODUCTION LEVELS (PERCENTAGE OF ALL PRODUCTS) FOR SELECTED SUBJECTS, 1980-84

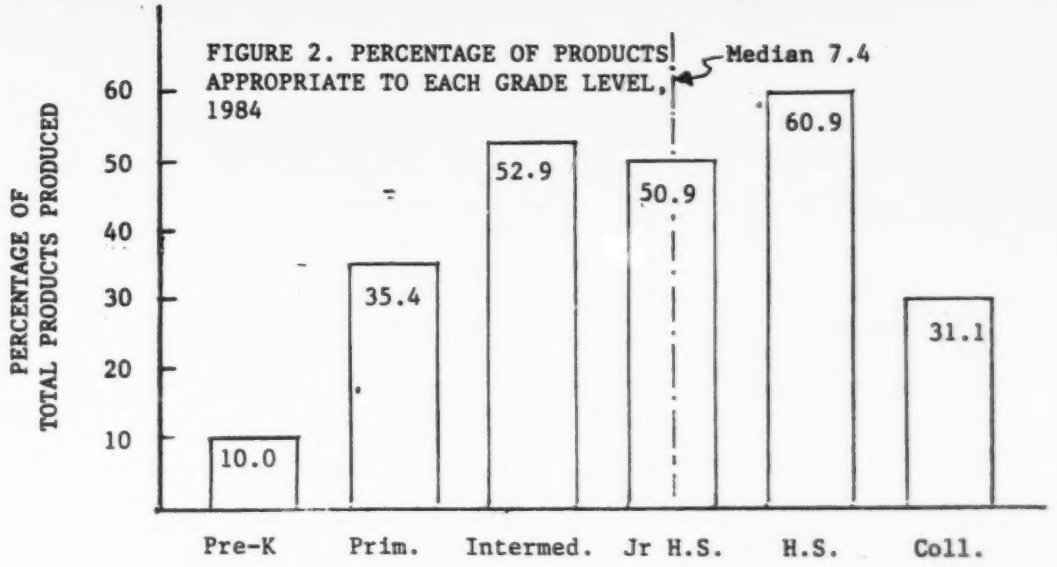


FIGURE 2. PERCENTAGE OF PRODUCTS APPROPRIATE TO EACH GRADE LEVEL, 1984
Median 7.4
PERCENTAGE OF TOTAL PRODUCTS PRODUCED
60
50
40
30
20
10
10.0
35.4
52.9
50.9
60.9
31.1
Pre-K
Prim.
Intermed.
Jr H.S.
H.S.
Coll.

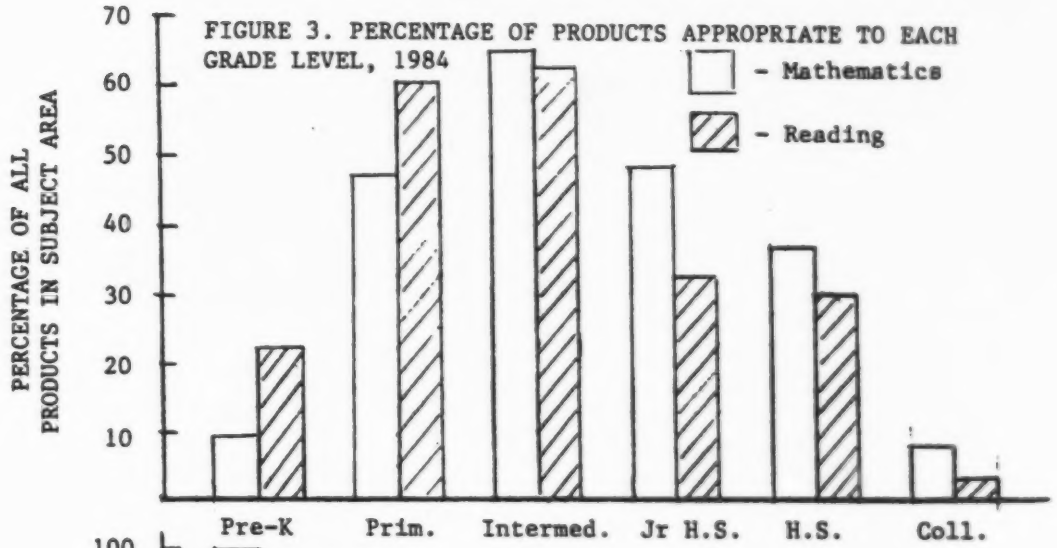


FIGURE 3. PERCENTAGE OF PRODUCTS APPROPRIATE TO EACH GRADE LEVEL, 1984
- Mathematics
- Reading
PERCENTAGE OF ALL PRODUCTS IN SUBJECT AREA
70
60
50
40
30
20
10
Pre-K
Prim.
Intermed.
Jr H.S.
H.S.
Coll.

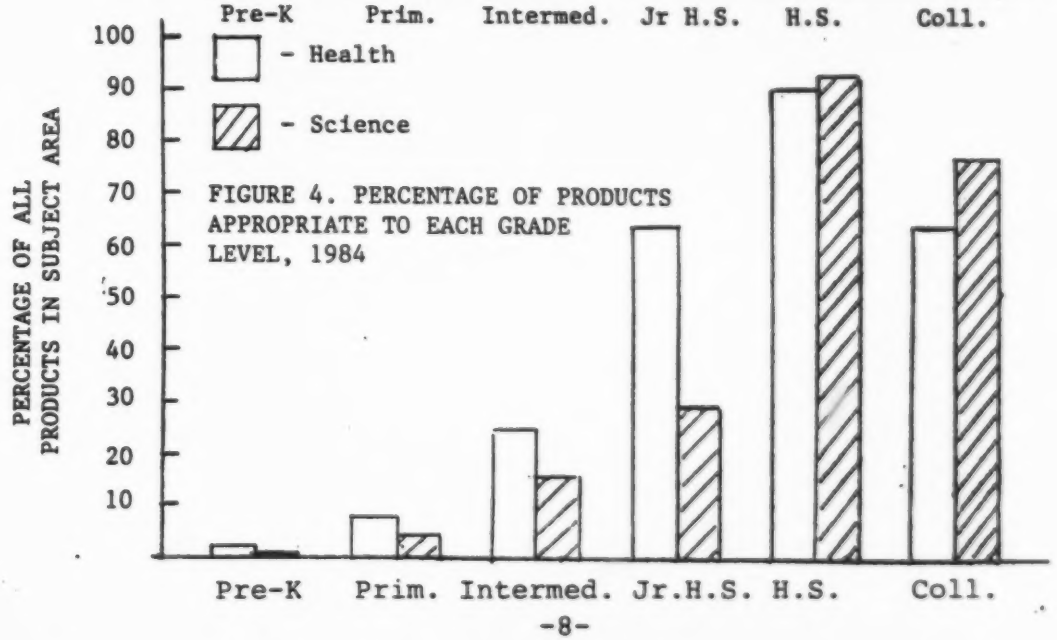

- Health
- Science
FIGURE 4. PERCENTAGE OF PRODUCTS APPROPRIATE TO EACH GRADE LEVEL, 1984
PERCENTAGE OF ALL PRODUCTS IN SUBJECT AREA
100
90
80
70
60
50
40
30
20
10
Pre-K
Prim.
Intermed.
Jr.H.S.
H.S.
Coll.

Figure 4 shows graphically the data for two of the subjects with high median grades, Health and Science. As in the case of Reading, the Health median of 9.8 is probably the result of the prevalent levels at which this subject is taught. However, it would seem that there must be many teachers who would welcome software tools with which to help younger pupils learn Health topics.

It is clear that the grade-level distribution for Science software is heavily skewed to the higher grades - the median grade is 11.1. A prominent Science educator has remarked to the author that this unusual distribution is explained by the fact that many elementary level teachers do not feel comfortable teaching Science, and that much more Science teaching goes on at the secondary level than in lower grades. Whether or not this is the case, it does not explain away the need for adequate science instruction at all levels. It is the opinion of the author that the dearth of products for elementary Science is one of the most serious shortcomings to be observed in the educational software field today.

In order to determine whether or not the grade level situations in Mathematics, Health, and Science have been changing over time, the median grade level of new programs produced in each of the years 1980 through 1984 was computed. Figure 5 shows graphically the results of these computations. The median grade level for Science products increased to a high of 11.4 in 1982, but has been declining since then, a trend which one hopes will continue this year and into the future. The trends for Health and Mathematics are less auspicious: The trendline for Health is almost perfectly horizontal, and the median grade level for new Math software has been decreasing steadily since 1980.

TYPES OF PROGRAMS PRODUCED

Table 4 shows the proportions of all instructional software products having as one of their components the listed software types. Because many products include more than one function, e.g, drill and practice combined with a game, the EPIE database has been designed to allow the assignment of more than one program type to a product. The obvious result is that one obtains a larger number of program types than products, and a sum of the percentages in any tabulation like Table 4 will exceed 100. A glossary of terms is included at the end of this paper for the use of those readers who are not familiar with the terms used here to dennote various kinds of programs.

CLASSIFICATION OF PROGRAM TYPES

It is possible to classify instructional program types in terms of the degree of structure imposed by a program and the relative amount of learner control afforded. Here is such a classification of some of the common instructional program

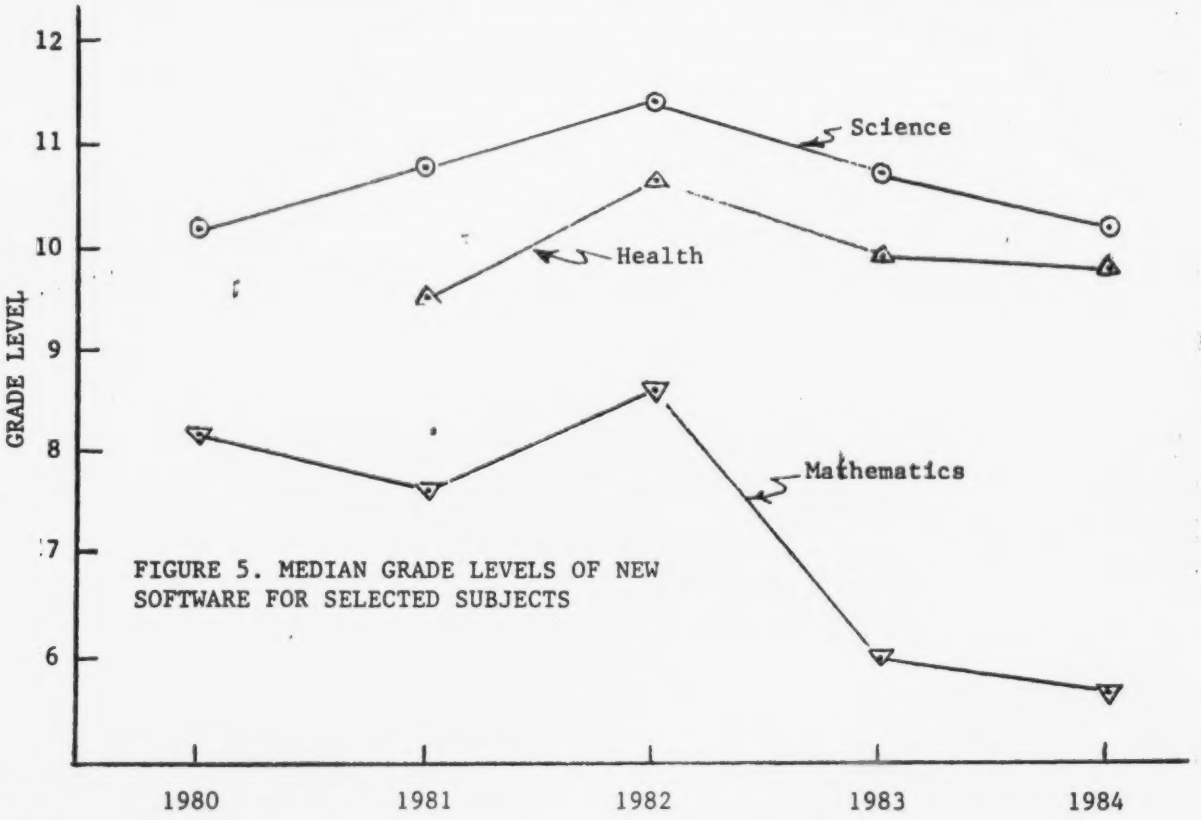
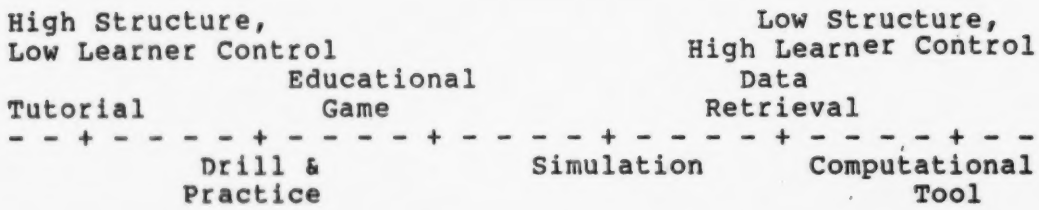


FIGURE 5. MEDIAN GRADE LEVELS OF NEW SOFTWARE FOR SELECTED SUBJECTS

Table 4. Proportion of Products Containing Each Program Type (10/84)

	Percentage
Drill and Practice	63.5
Tutorial	32.0
Educational Game	19.9
Computational Tool	8.6
Simulation	8.1
Teacher Aid	3.8
Test Generation	3.4
Concept Demonstration	2.2
Class Management	1.5
Data Retrieval	1.4
Other	1.4

types:



In the stereotypical tutorial program, the author attempts to embody the entire instructional process, presenting all material, giving examples, giving practice in its application, measuring learning, and carrying on remediation if indicated. Hence, this type of program is seen as highly structured and as affording relatively little learner control. At the other end of the spectrum, the computational tool program, such as a word processor or spreadsheet program, closely analagous to a pencil or calculator, imposes very little structure on the learning process and offers the maximum learner control. The other program types shown are distributed along the structure/control spectrum in the order shown in the figure but at intervals not as regular as those shown. Of course, any given product may exhibit a greater or lesser degree of learner control than the average for its type, but the stereotypes seem to be valid within broad limits.

For several years, a lot of questions have been raised about the advisability of using software on the high structure/low learner control end of the spectrum. Many have criticized these programs as being poor uses of expensive hardware resources; they see tutorials as nothing more than automated textbooks and drill and practice programs as no better than workbooks. Some also have suggested a possible negative personal or social impact resulting from what they see as an extremely mechanistic and authoritarian approach to teaching. The task here is not to try to enter into this controversy, but merely to indicate where the software field seems to be going relative to the concerns that educators have.

PROGRAM TYPE ACROSS ALL SUBJECT AREAS

Figure 6 shows the distribution of the entire software pool on the structure/control spectrum as exemplified by the relative proportions found of the six program types just discussed. Note that about one-third of all software products have tutorial components and nearly two-thirds contain drill and practice elements. Clearly, the broad software population is heavily skewed toward high structure and low learner control.

PROGRAM TYPE BY SUBJECT AREAa

Products for only two subject areas, Health and Fine Arts, exhibited high proportions of the program types on the high

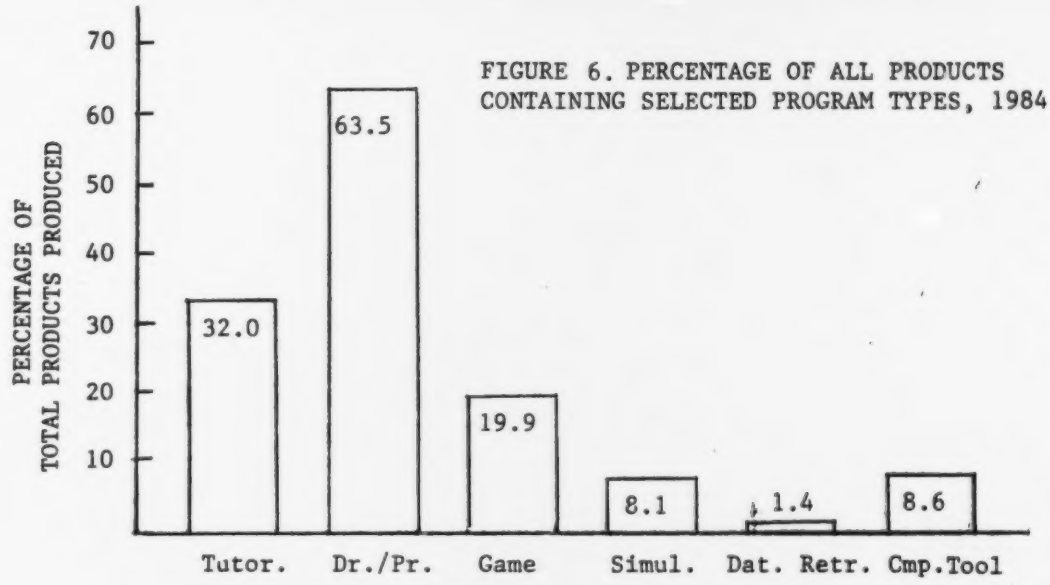


FIGURE 6. PERCENTAGE OF ALL PRODUCTS CONTAINING SELECTED PROGRAM TYPES, 1984

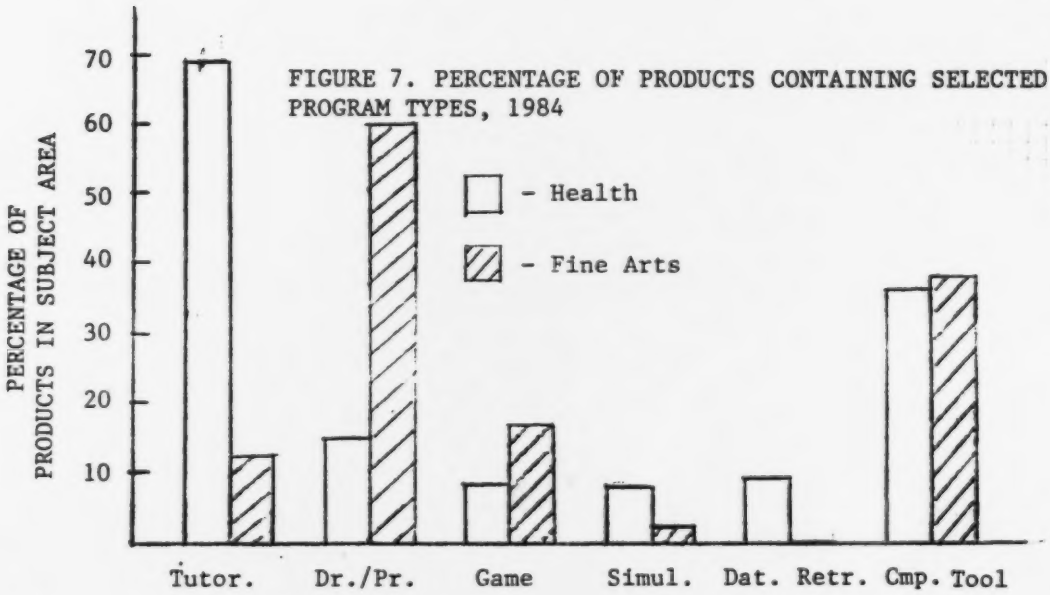


FIGURE 7. PERCENTAGE OF PRODUCTS CONTAINING SELECTED PROGRAM TYPES, 1984

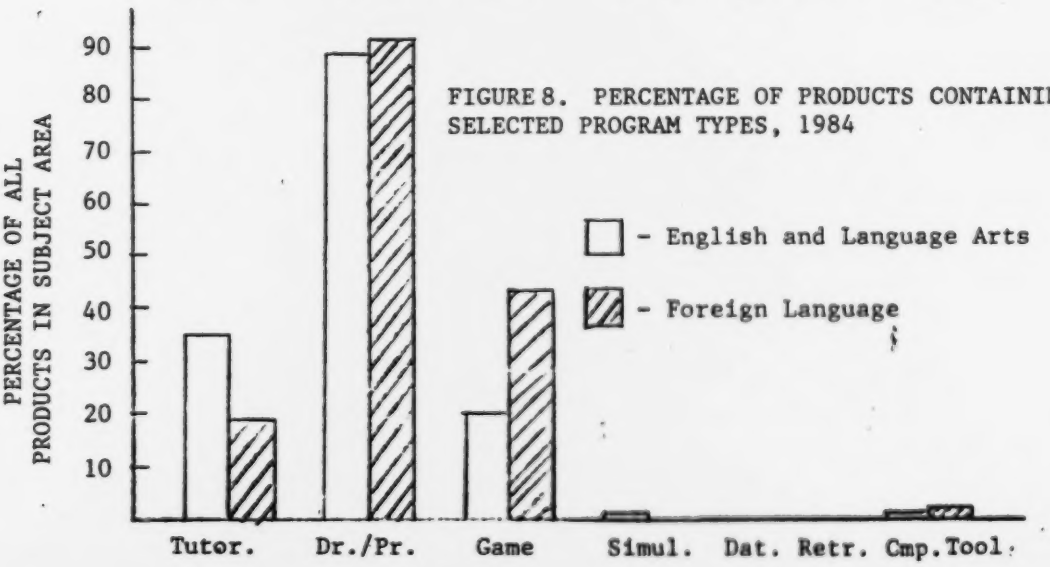


FIGURE 8. PERCENTAGE OF PRODUCTS CONTAINING SELECTED PROGRAM TYPES, 1984

learner control end of the spectrum. Science, the closest subject to the two highest ones, had significantly lower proportions of high learner control program types. Figure 7 shows the profile of program types for Health and Fine Arts.

As would be expected given the decided skew of the total body of software toward low learner control, many subject areas exhibited this tendency. The two subjects which were at the extreme in this regard were English/Language Arts and Foreign Language; they were followed closely by Library Skills and Reading. Figure 8 shows the program type profile for the two subjects at the extreme extent of high structure and low learner control. It is interesting that all of the subject areas with the lowest learner control profiles are in the same general universe, namely communications skills.

TRENDS IN PRODUCTION OF PROGRAM TYPES

In order to try to determine whether production of the various program types has been accelerating or decelerating, the percentage of each program type produced in each of the years 1980-84 was computed and graphed. The output of games and drill and practice, data retrieval, and computational tool programs was almost level for the five years considered, and in each case was quite close to the proportions given for these types in Table 3.

However, the graphs for tutorials and simulations were not level; they are shown in Figure 9. It appears that the production of tutorial programs decelerated from 1980 through 1982 and then reversed itself, climbing rapidly to a level in 1984 almost as high as that in 1981. The change for output of simulation programs was just the reverse, but more gradual: Production levels increased through 1982 and then declined for two years. If these two graphs are valid and the indicated trends continue, particularly the one for tutorials, it would appear that educators can expect an even greater proportion of low learner control programs in the future.

SOFTWARE QUALITY

It would be desirable, of course, to evaluate all instructional software empirically under controlled conditions. Unfortunately, the quantity of software on the market makes this a totally impractical alternative. However a substantial number of agencies have undertaken to publish evaluations done by their own staffs, or by consulting writers and educators, based on inspection of programs' internal characteristics and on observation of their use by learners. Many of these evaluations have been done by teachers who have used the products with students or by persons who have observed such use, but very few have included any kind of experimental controls. Even with many organizations involved, evaluations have been published on only a small proportion of available products.

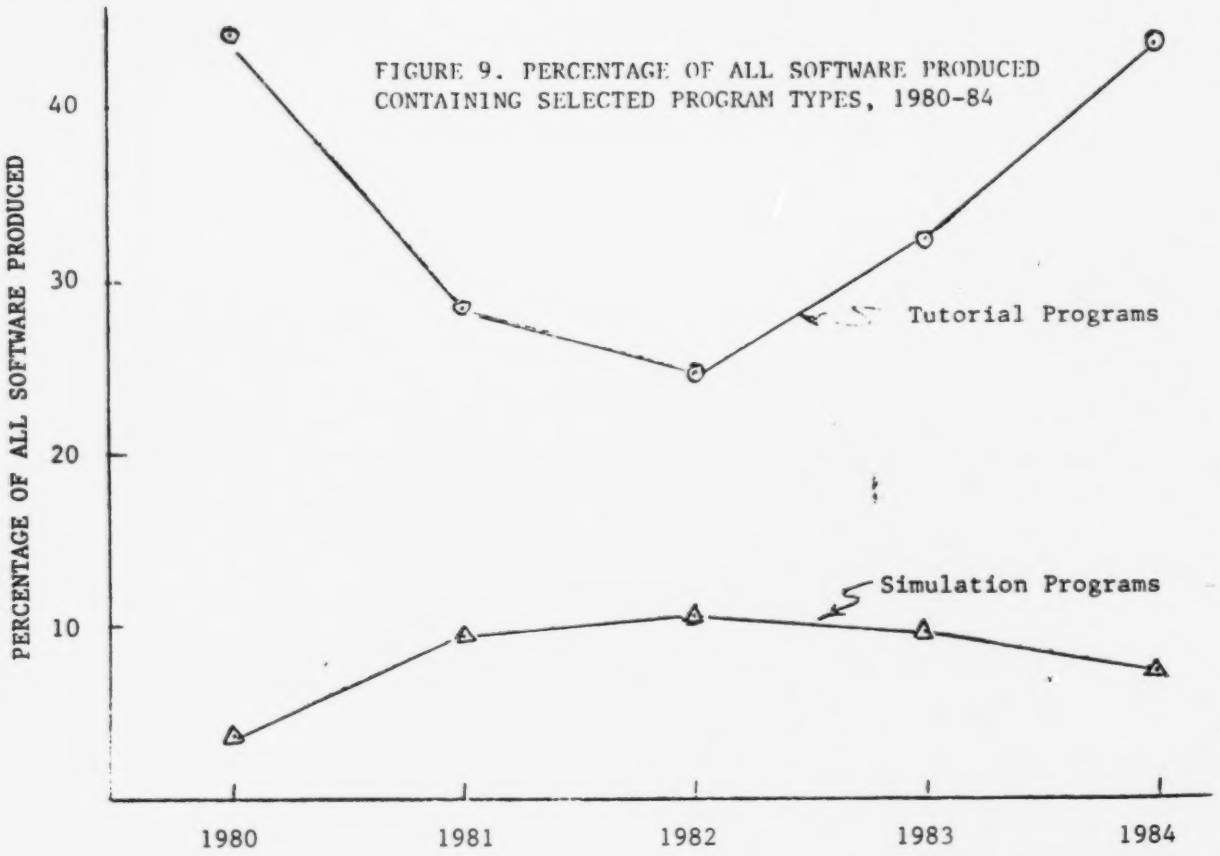


FIGURE 9. PERCENTAGE OF ALL SOFTWARE PRODUCED CONTAINING SELECTED PROGRAM TYPES, 1980-84

One of EPIE's most popular products is its software evaluation service which uses teams of trained analysts to produce Micro-Courseware PRO/FILEs, in-depth reports on individual pieces of instructional microcomputer software. In addition to doing its own evaluations, EPIE has carefully selected a group of 29 publications and services which produce evaluations that are considered to be sufficiently reliable for citing by EPIE. These publications and services are listed in the Appendix.

PROPORTION OF PRODUCTS EVALUATED

EPIE found that 1,474 of the 6,126 (24.1 per cent) products in its database as of October, 1984 had been evaluated by EPIE or non-EPIE sources. In total, there were 3,101 evaluations, for an average of 2.1 evaluations per product; the number of evaluations ranged widely, from one to nine per product.

In terms of subject areas, the proportion evaluated ranged from 1.8 per cent of Industrial Arts programs to 37.9 per cent of products for Logic and Problem Solving. Besides Logic and Problem Solving, the subjects highest on this measure were Fine Arts (37.3 per cent), Mathematics and Library Skills (30.4 per cent each), and Early Childhood (30.0 per cent). Sharing the honors for lowest proportion of products evaluated were Guidance (4.9 per cent) and Foreign Language (14.7 per cent).

CRITERIA OF QUALITY

Each EPIE Micro-PRO/FILE has associated with it two numeric ratings in the range 1 to 10 which summarize the considered opinions of the team which conducted the evalution. One rating is for instructional design, the other for program design. When the two numbers are averaged together, the result corresponds to an EPIE statement of quality as follows:

8 - 10	Highly recommended.
6 - 7	Recommended with reservations.
4 - 5	Not recommended but may meet some needs.
1 - 3	Do not consider.

This EPIE numeric rating is used here as one indicator of product quality.

EPIE, with the help of the State of California's TECC Software Library and Clearinghouse, has assigned a rating of positive, neutral/mixed, or negative to the evaluations done by the 29 other review sources mentioned above. In order to manipulate these ratings more easily for the purposes of this study, corresponding numeric values of 1 (positive), 0 (neutral/mixed), and -1 (negative) were assigned to them. Where more than one non-EPIE agency had evaluated a product, a summary rating was obtained by adding algebraically the individual numeric ratings corresponding to the different evaluations and taking the average. Clearly, this always results in a number in the range $-1 \leq n \geq 1$.

QUALITY LEVELS

By October, 1984, EPIE had evaluated 575 of the products in its database. The average of all the ratings assigned by EPIE was 4 out of 10, which translates to "Not recommended but may meet some needs". The database also included citations to reviews of 1,213 products by non-EPIE sources. The average of the ratings assigned to these evaluations was .60, which can be thought of as a little better than midway between neutral (mixed) and positive. It should be apparent from comparing these two averages that EPIE is a much more conservative evaluation agency than the other sources when taken together as a group.

QUALITY BY SUBJECT AREA

Table 5 is a list of average EPIE and non-EPIE evaluation ratings of programs in all subject areas where at least 20 per cent of the products had been evaluated. Others were not listed because it was considered that the number of reviews were too small to be representative of the subject areas.

Table 5. Average Evaluation Ratings
of Programs by Subject (10/84)

	EPIE Ratings	Non-EPIE Ratings	Products Reviewed
Fine Arts	7	.93	57
Teaching About Computers	6	.91	62
Logic & Problem Solving	6	.78	36
Early Chilhood	5	.53	42
Business	4.5	.57	27
Science	4	.70	234
Mathematics	4	.57	479
Reading	4	.47	150
English and Language Arts	4	.32	140
Social Studies	3	.37	66
Library Skills	2	.67	14

Note that Table 5 entries are shown in descending order of ratings; where a conflict existed between EPIE and non-EPIE reviews, the EPIE rating was given priority as coming from the more conservative source. Programs for Fine Arts (Art and Music) clearly received the best ratings, and, significantly, this is the subject area that also had the second highest proportion of products reviewed. It is interesting that Fine Arts products also were ranked highly on low structure/high learner control.

It is unfortunate that products for such very widely taught subjects as Mathematics, Reading, and Social Studies received such mediocre rankings. Perhaps this is partly due to the fact that these subjects were among the earliest ones to be heavily involved in computer-oriented instruction. This, plus the downward production trend cited earlier for Math and Reading, would lead one to expect a larger proportion of old, and therefore not as technically advanced, products for these subject areas. The same reasoning also might apply to Science products, but they were given a much higher rating by non-EPIE agencies than were programs for the other three subjects.

TRENDS IN SOFTWARE QUALITY

Figure 10 shows the change in software ratings for programs produced in each of the years 1980 through 1984. It contains separate graphs of the average ratings of all instructional software given by EPIE and non-EPIE evaluation sources. It is clear that both EPIE and non-EPIE ratings follow the same trend: An increase to 1982, then a two-year plateau, followed by a very slight increase through 1984. Note that the highest level reached by EPIE average ratings, 5.5, is still in the "Not recommended but may meet some needs" range. Since the non-EPIE

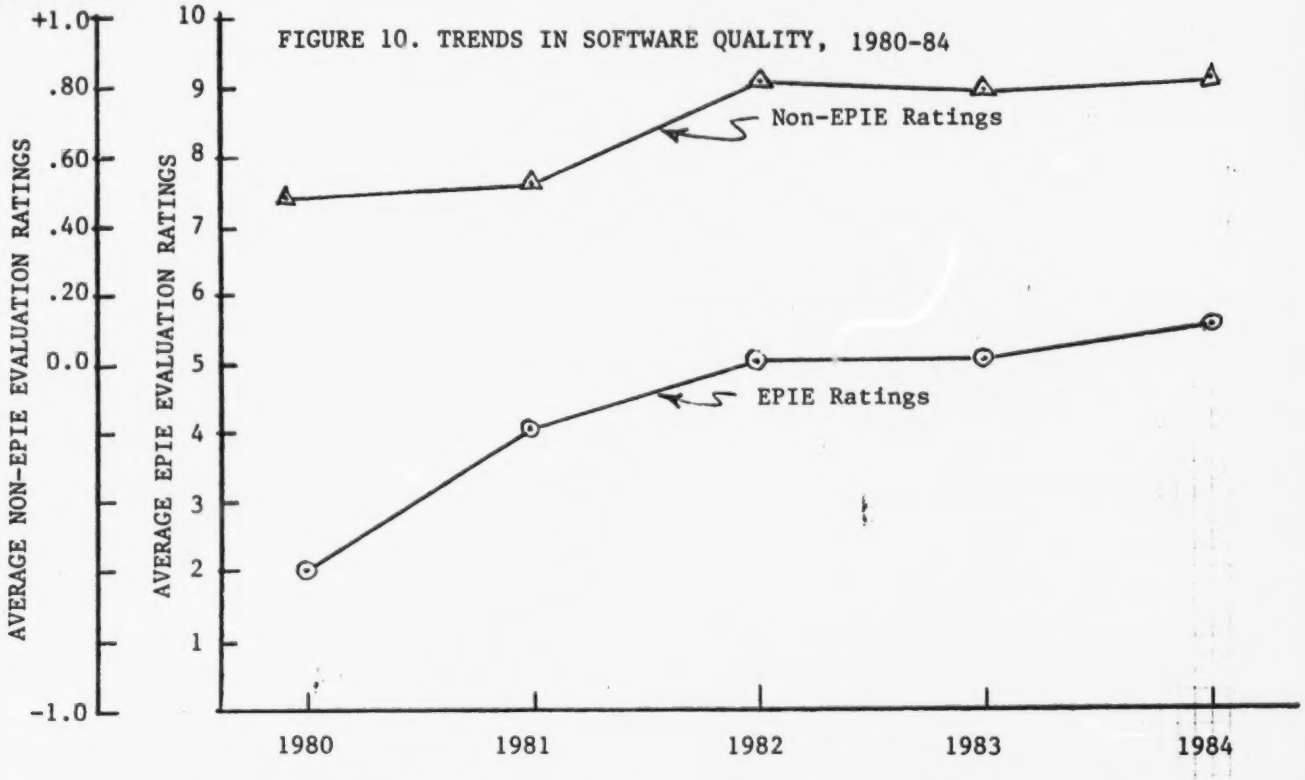


FIGURE 10. TRENDS IN SOFTWARE QUALITY, 1980-84

ratings reached a fairly high level (about 80% of the way from neutral to positive), a conservative consolidated rating would be, from EPIE's viewpoint, in the low end of the "Recommended with reservations" range.

From a positive standpoint, it is encouraging that much of the software produced in 1982 through 1984 received higher ratings than did older software. On the other hand, it is anything but encouraging that the upward trend seems almost to have stalled out.

CONCLUSIONS

Although computers have been used in schools since at least 1964, and microcomputers since 1977, the educational software field is still in its youth. Not surprising for a young organism, it is still growing rapidly and has not yet reached its potential.

Based on the results of this study, the main weaknesses of the instructional software field are:

1. There is not enough software to adequately support most teaching objectives and individual differences among students. The most glaring inadequacies in this regard are in Business, Social Studies, secondary Mathematics, and elementary Science.

2. There is a strong predominance, which may be increasing, of high structure, low learner control programs in most subject areas, most notably English/Language Arts, Library Skills, Foreign Language, and Reading.

3. The over-all level of software quality is barely adequate and is improving only very slowly. The subject areas whose products have received the lowest ratings on the whole are Library Skills, Social Studies, English/Language Arts, Reading, and Mathematics.

4. Although many agencies, including EPIE, are evaluating as many products as available resources will allow, only about a quarter of products now on the market have been evaluated well. The worst subjects in this regard are Foreign Language, Guidance, Health, and Industrial Arts.

On the brighter side, the educational software field has some impressive strengths:

1. A substantial volume of new products is being designed, averaging about 2,000 new products every year.

2. There is a large body of producers, over 700 companies, providing vigorous and healthy competition.

3. In a few subject areas, notably Fine Arts and Health, a respectable number of low structure, high learner control products are being produced.

4. The quality of software products for a few subject areas has been rated highly on the average, especially programs for Fine Arts, Teaching About Computers, and Logic and Problem Solving.

RECOMMENDATIONS

Although space does not allow much discussion of suggested courses of action, the author would feel remiss if he did not at least mention the following points. In order to improve the quantity and quality of available software, several different parties need to take action. First and foremost is the individual educator: He or she must send a message to producers which informs them of what must be produced. In terms of quantity, this may be simply a matter of telling the producers, through letters, articles, word of mouth, etc., where the needs are in terms of subject areas, grade levels, and topics. Producers want to build products that they think will sell, and if they are told by enough consumers that products to support a given area are needed, they will expect that to translate to sales and act accordingly.

In terms of quality, individual educators must send a message to producers by becoming better consumers. This entails teaching themselves about the attributes of good software and how to preview, specifying their own software needs, getting access to adequate supplies of evaluations in their own subject areas, refusing to purchase products without preview, and refusing to purchase products which do not meet quality standards. Many of these activities can be facilitated by local and regional professional organizations.

The help of regional and governmental agencies also is needed to help improve software quality. State, county, and other regional agencies should continue to expand the number of software libraries and previewing centers. Governmental agencies and foundations should provide funding to support teacher education in software evaluation, preview centers, and the operation of organizations which evaluate educational software. Support of evaluation efforts is especially important, as the magnitude of the job to be done far outstrips the resources currently available to accomplish it.

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GLOSSARY OF PROGRAM TYPES

CLASS MANAGEMENT - The computer is used to monitor student achievement against a set of prescribed learning objectives. A class management system usually includes components for test scoring and performance reporting. It also may include facilities for entering one's own objectives and individual lesson prescriptions, and for test generation.

COMPUTATIONAL TOOL - An application of the computer in which its speed and storage capacity are used to enhance the student's faculties, e.g., intellectual and motor skills, in such a way as to allow him or her to accomplish tasks more readily. Examples include spreadsheets, statistical processors, database managers, and painting programs.

CONCEPT DEMONSTRATION - The computer is used to illustrate, usually dynamically, the operation of a principle, e.g., daily compounding of interest, a function approaching a limit, etc.

DATA RETRIEVAL - The computer is used to place at the student's disposal a large body of data about a given situation (e.g., census or election results) as a laboratory for testing of alternate hypotheses to explain a phenomenon in the situation, e.g., why one section of the country has traditionally given strong support to a particular political party.

DRILL AND PRACTICE - The computer is used to provide exercises to drill the student on facts and/or to give practice on new skills such as factoring, conversion between metric units, musical pitch discrimination, etc. Immediate feedback is given to the student regarding his or her responses. A program also may record and report performance.

EDUCATIONAL GAME - The computer plays, or provides computational support for, a game in which one or more students participates and in the process of which he or she learns new concepts or skills.

SIMULATION - The computer is used to model a real-life or imaginary situation in a dynamic fashion so that students may interact with it and thereby learn about it. Worthwhile simulations usually embody situations which students could not experience otherwise because of financial, safety, time, or other constraints, e.g., experimenting with the factors impinging on a body of water undergoing pollution.

TEACHER AID - The computer is used to serve the teacher in ways which will improve his or her efficiency, especially by saving time. This may include recording and reporting of marks, statistical analysis of grades and other kinds of data, etc.

TEST GENERATION - The computer is used to generate quizzes or tests, based on specifications provided by the user (e.g., objectives to be tested, difficulty level, number of problems,

problem formats, ets.).

TUTORIAL - This is what has traditionally been known as CAI. The computer is used to implement most of the instructional process. A comprehensive tutorial sytem may contain provisions for all of the following: student placement, introduction of new material, drill, practice, performance monitoring, remediation, and reporting of progress.